

OE Visualization and Controls Peer Review

FAULT VISUALIZATION

Integration of Substation IED
Information into EMS Functionality

Washington DC,
October 2006



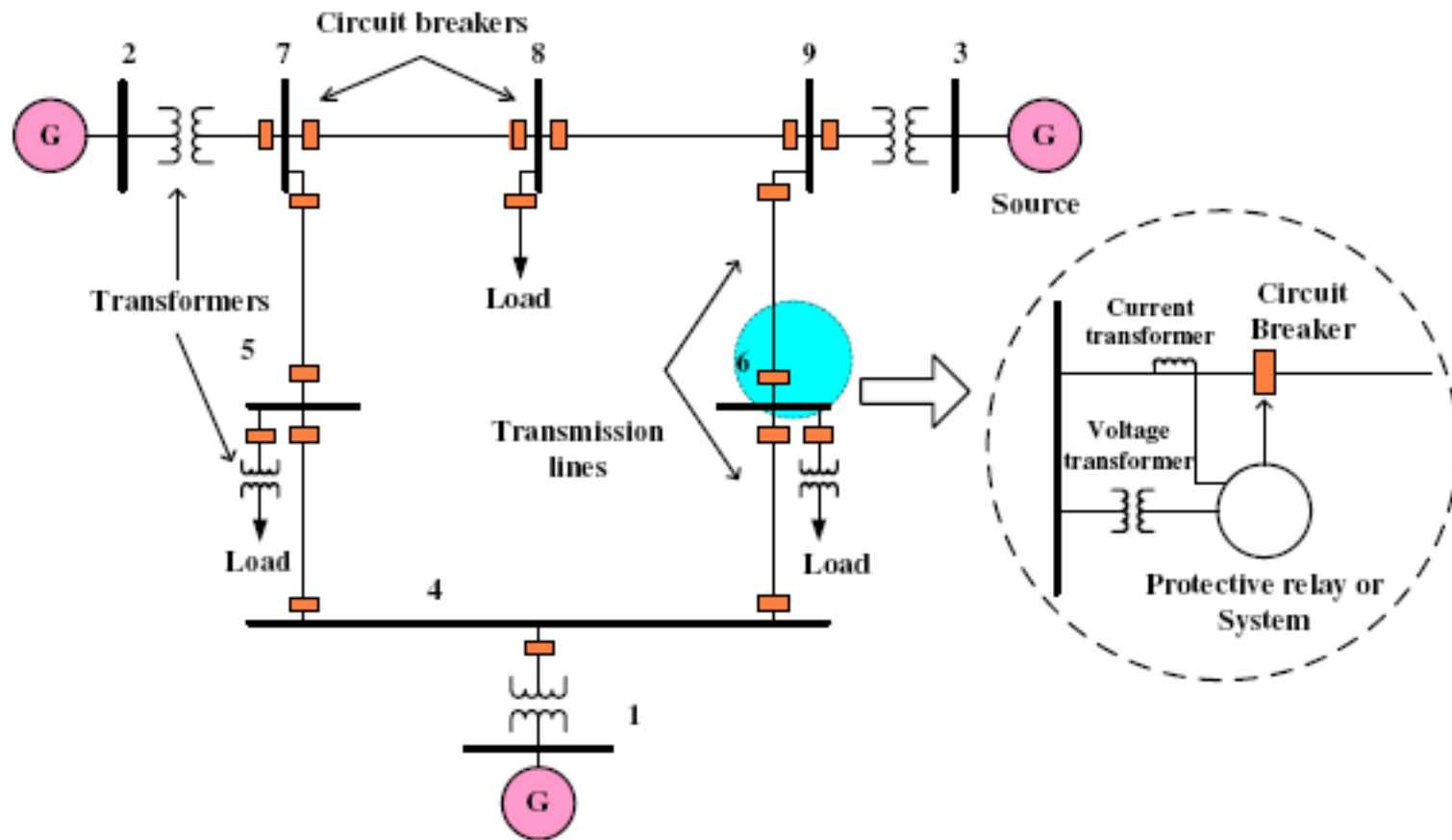
Outline

- Programmatic Goals
- Background
- Existing Approach
- New approach
- Benefits
- Conclusions

Programmatic Goals

- Electric T&D Programs:
 - a) Expansion of Monitoring and Control capabilities using GPS,
 - b) Deployment of time-synchronized measurements
 - c) Development of improved fault location
 - d) Improvement of operator tools for detecting physical disturbances
- OED&E, Transmission Reliability Program:
Grid Reliability R&D

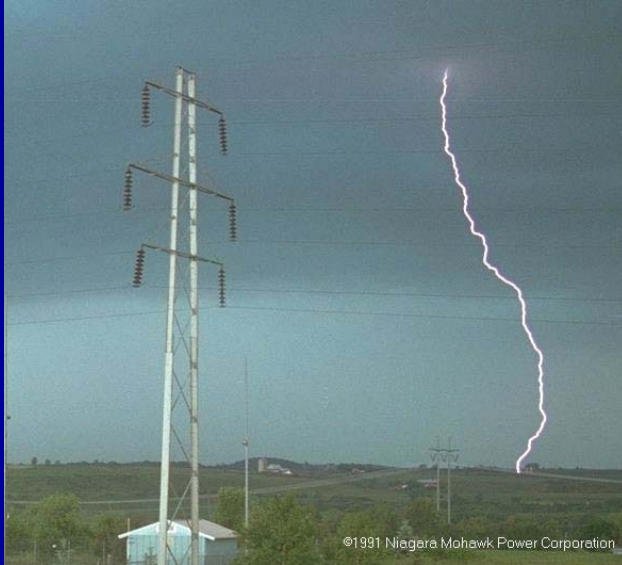
Transmission Line Protection



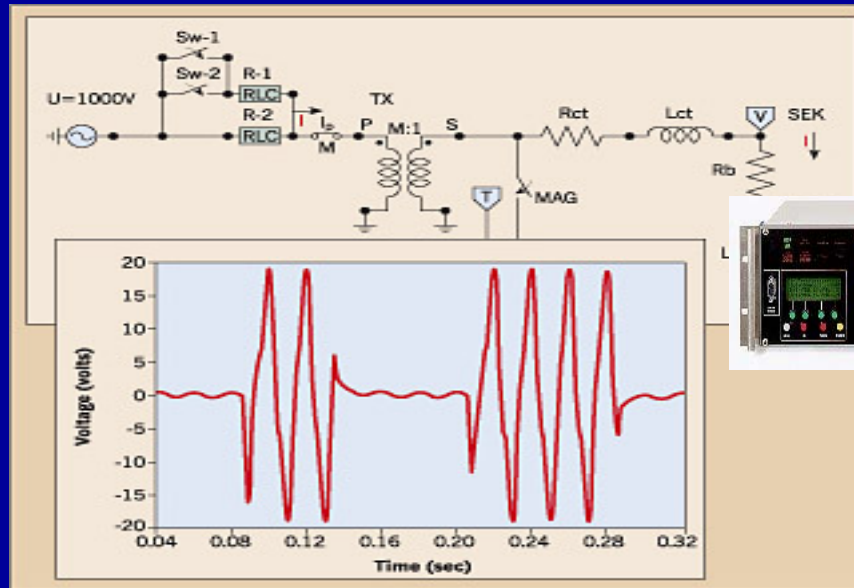
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Possible causes of faults



Fault occurrence and reaction



Relays



Trip signal

Fault is temporary

Fault is permanent



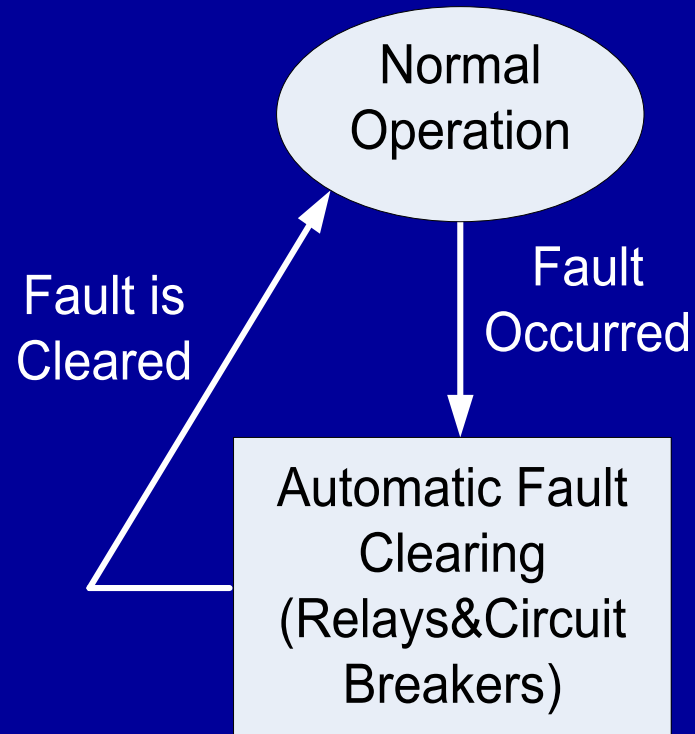
Circuit breakers 7



Type of fault: temporary

Equipment reacts automatically.
Fault is cleared.

No need for operator action, but
event is recorded and archived.



Type of fault: permanent



Automatic fault clearing makes decision to disconnect faulted part of the power system without any more attempts to automatically recover disconnected part → LOCKOUT
→ Disconnected part must be returned to working state MANUALLY

The role of personnel when fault occurs

Operator tracks system 24/7; coordinates other groups as needed. **Output:** Event report

Protection Group analyzes events 8am-5pm; identifies fault location and equipment misoperation.

Output: Comprehensive analysis report

Maintenance responds to calls 24/7; inspects and repairs equipment as needed. **Output:** Repair report from field visits

Tools to deal with faults



SCADA



DFR



Archives

[illegible]

IEDs



Test equipment

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Archived data

Summary report

Fault Information

Fault cleared

Alarm

Protection group

SCADA

Maintenance

Normal
Operation

Protection Group

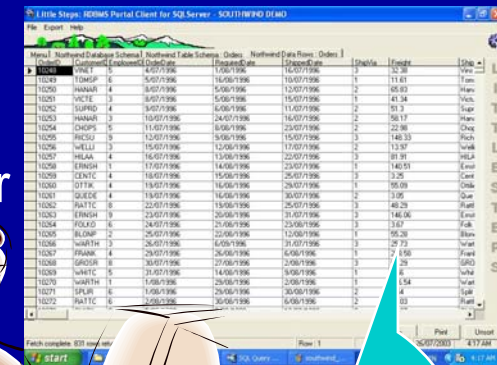
Archived data

Fault
Occurred

Automatic Fault
Clearing
(Reahys&Circuit
Breakers)

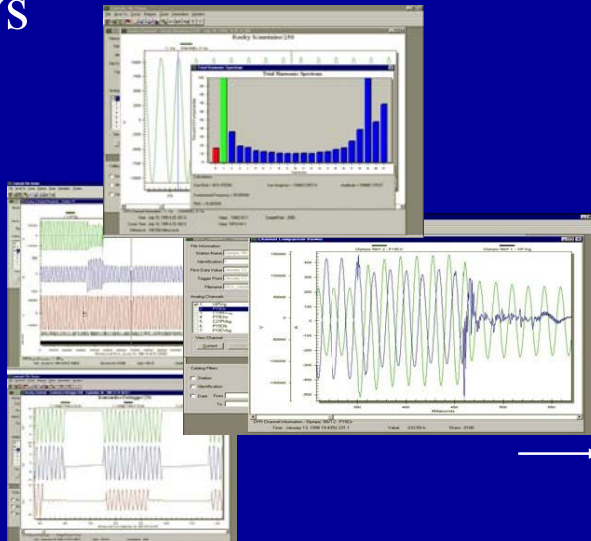
Protection group is
notified automatically

Operator



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Relays



Fault location and/ or
equipment misoperation

DFR



Protection group
analysis data

Maintenance

Operator-
Operational data



Fault Cleared
Alarm

Archived data

Event	Time	Location	Severity	Status	Clear Time	Clear Location	Clear Status	Clear Time	Clear Location	Clear Status
10001	10/01/2002	10001	1	1	10/01/2002	10001	1	10/01/2002	10001	1
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Fault
Information

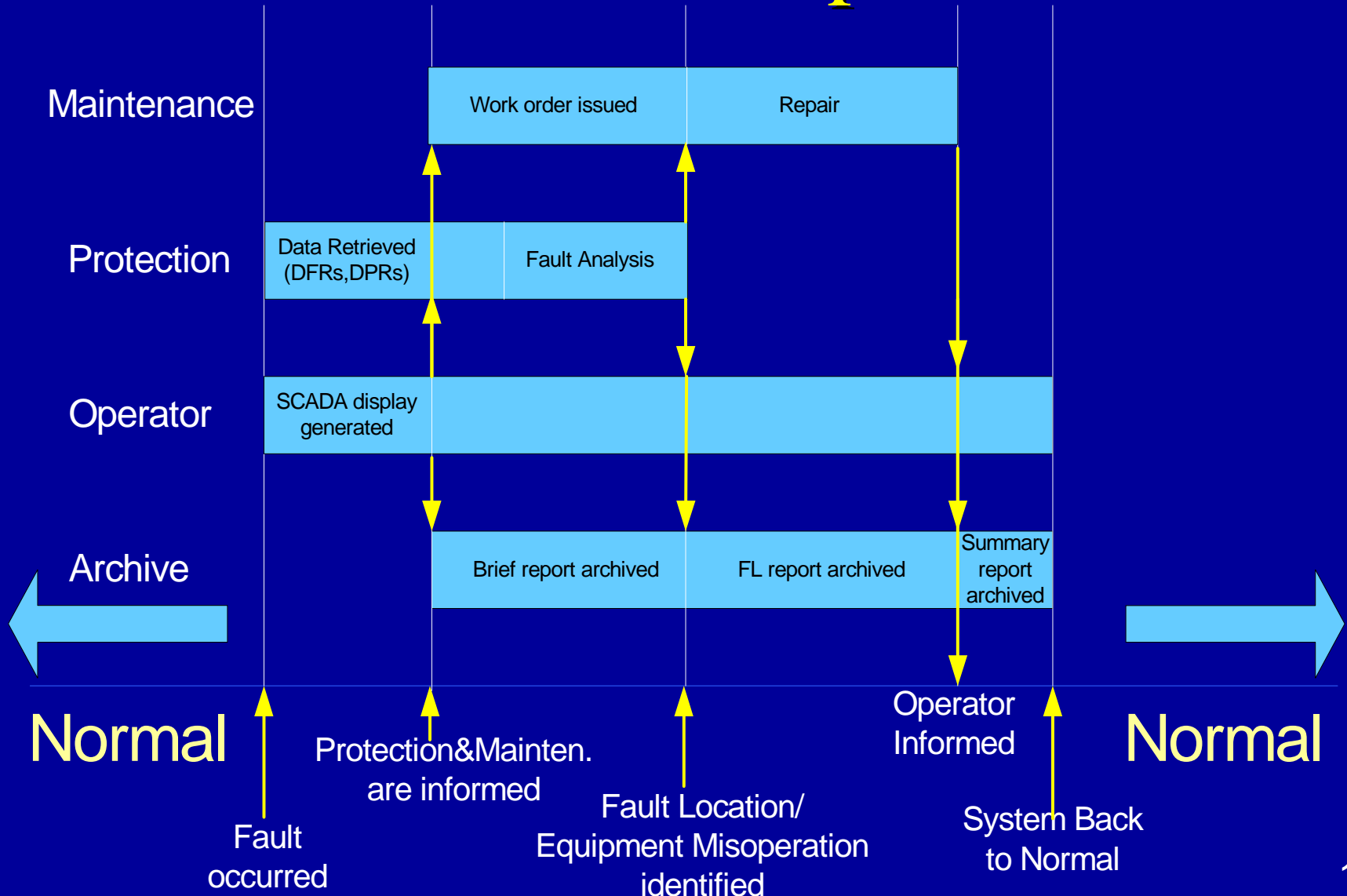
Summary
report



Maintenance



Timeline: Fault is permanent



Shortcomings

- Data and information
 - Incomplete and imprecise data
 - No automated information extraction
- Decision and action
 - Inconsistent accuracy of fault location
 - Lack of specific instruction for action
- Personnel productivity and response time
 - Burden on utility personnel
 - Long restoration time

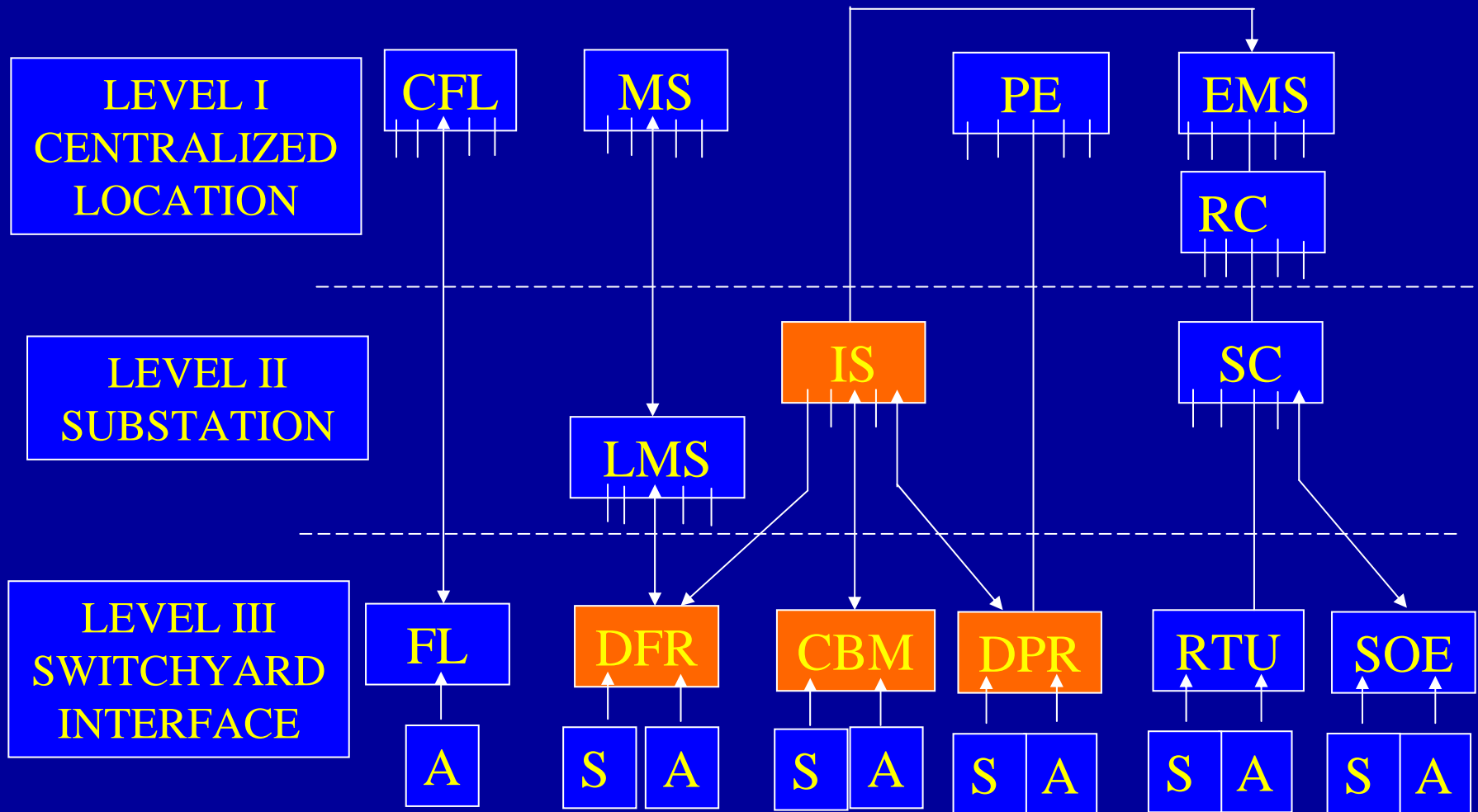
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New Approach

- Data and information
 - Increased availability and precision of data
 - Automated information extraction
- Decision and action
 - Fault location algorithm with optimal accuracy
 - Specific instruction for action automatically issued
- Personnel productivity and response time
 - Less time spent for analysis and restoration
 - Less people involved

Infrastructure



New Features

- New data from substation IEDs
- New displays for different user groups
- New quality in decision making
 - speed (decision making and data retrieval)
 - accuracy (redundant data, new algorithms)
 - automation (data retrieval and analysis)

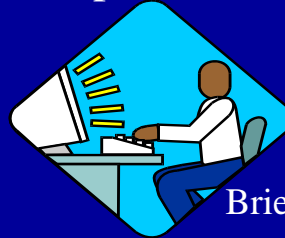
New Features

Protection Group



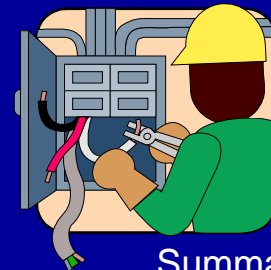
Comprehensive
Report

Operator

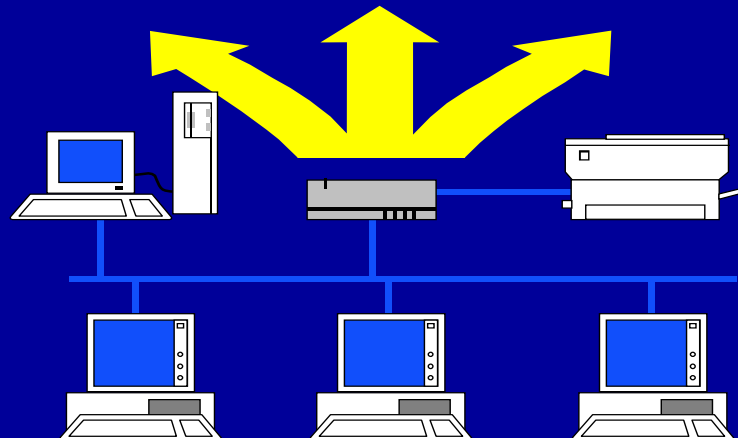


Brief Report

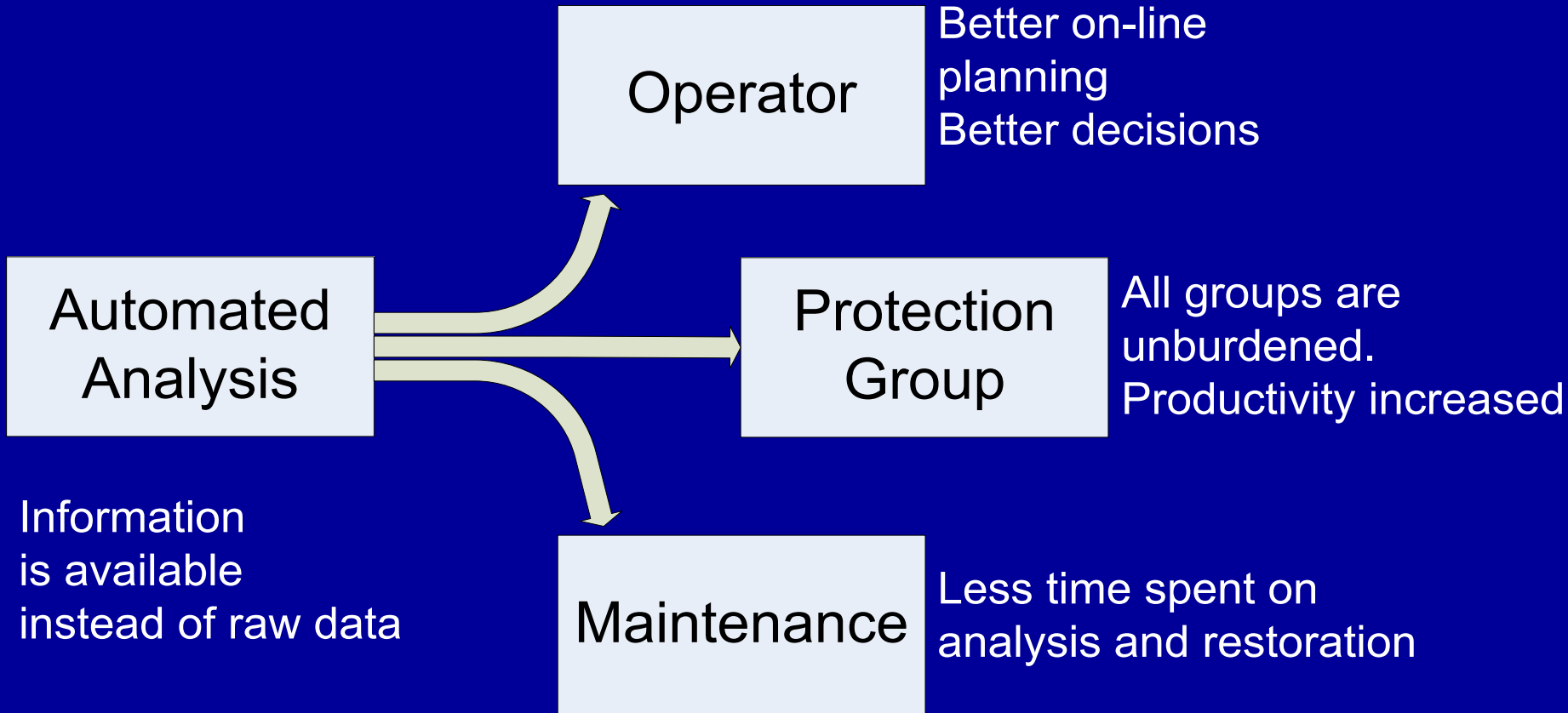
Maintenance



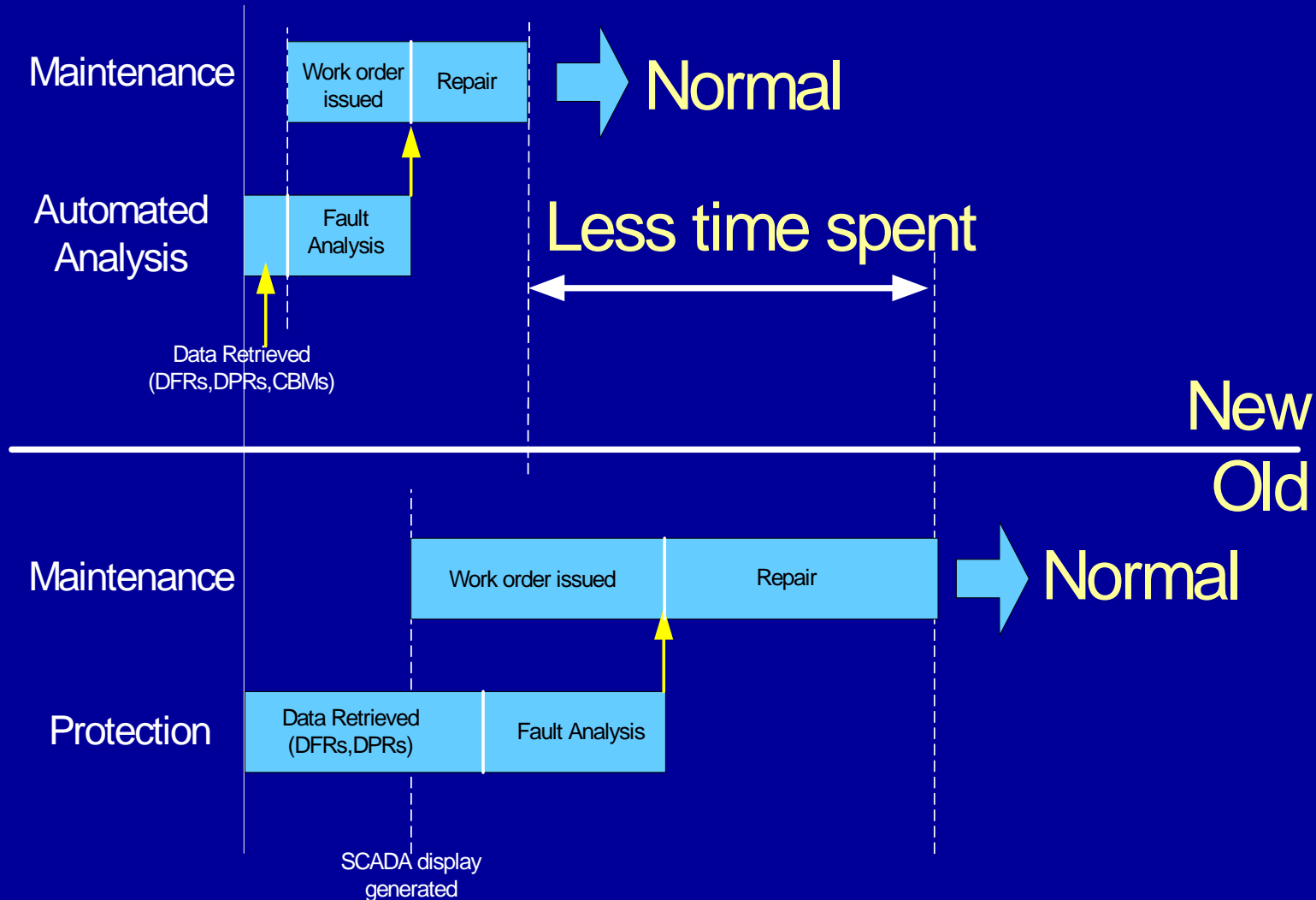
Summary
Report



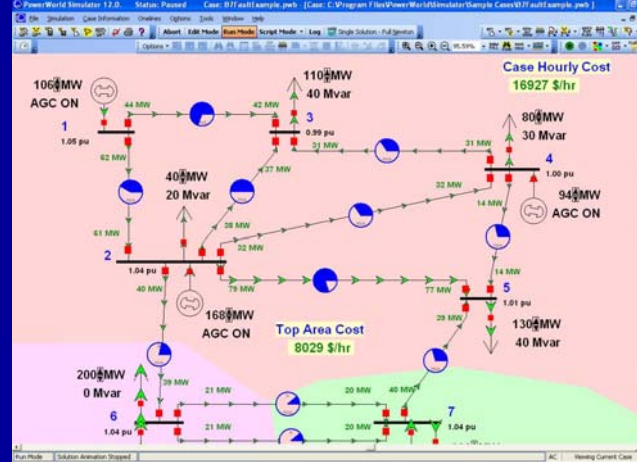
New Features



Timeline: Fault is permanent



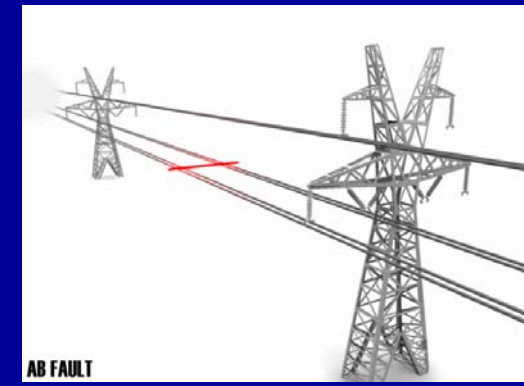
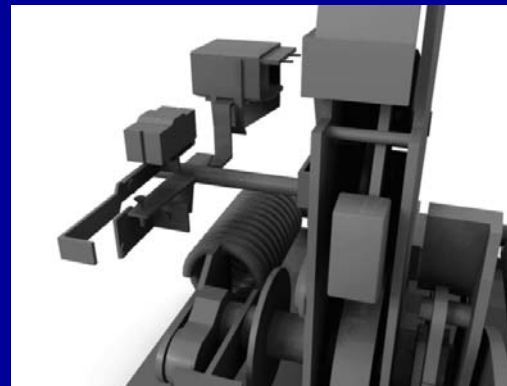
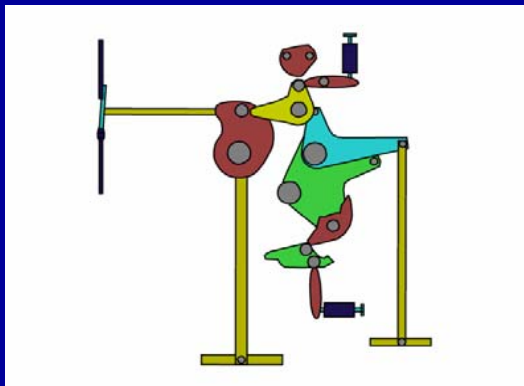
Power World software Topology



Fault Location



Equipment



Outline

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Benefits

- Data and information
 - Data are collected automatically
 - Availability of relevant data to each group
 - Automatic report retrieval and archival
- Decision and accuracy
 - Automatic analysis speeds up decision making
 - Avoiding possible human mistakes.
 - Optimized Fault Location Algorithm
- Personnel productivity and response time
 - Less people are involved (protection unburdened)
 - Less time is spent on fault clearing
 - Better and faster response

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Conclusions

- Value regarding programmatic goals: more reliable monitoring using GPS-related technologies
- Technical merit: new fault location algorithm based on new input data
- Emphasis on transfer of technology: CCET partnership aimed at commercialization
- Overall performance: on time, with all the goals met so far